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DRIFT: An Analysis of Outcome Framing in Intertemporal Choice

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People prefer to receive good outcomes immediately rather than wait, and they must be compensated for waiting. But what influences their decision about how much compensation is required for a given wait? To give a partial answer to this question, we develop the DRIFT model, a heuristic description of how framing influences intertemporal choice. We describe 4 experiments showing the implications of this model. In the experiments, we vary how the difference between a smaller sooner outcome and a larger later outcome is framed—either as total interest earned, as an interest rate, or as total amount earned (the conventional frame in studies of intertemporal choice)—and whether the larger later outcome is described as resulting from the investment of the smaller sooner one. These alternate frames have several effects. First, the investment language increases patience. Second, the explicit provision of the (otherwise implicit) experimental interest rate sharply reduces the magnitude effect. Correspondingly, we find that interest frames increase patience when the rewards are small, but they decrease patience when they are large. Third, the interest-rate frame induces somewhat *greater* discounting for longer time periods and, thus, reverses the common finding of "hyperbolic" discounting. Thus, many of the "stylized facts" implied by studies involving choices between a smaller sooner and a larger later amount are eliminated or reverse under alternate outcome frames.

Keywords: intertemporal choice, delay discounting, framing, choice modelling

Any interesting choice involves tradeoffs. For intertemporal choices, the tradeoffs involve time and amount—smaller sooner rewards compared with against larger later rewards. For some, the perfect real world example may be the decision of whether to endure lower (or no) wages during college so as to permit greater earnings later.

The dominant method for investigating intertemporal choices in the lab has been to elicit choices between smaller-sooner and larger-later amounts of money (see, e.g., Ainslie & Haendel, 1983; Hardisty & Weber, 2009; Kirby, 1997; Read, 2001; Sayman & Öncüler, 2009; Weber et al., 2007; Zauberman, Kim, Malkoc, & Bettmann, 2009). Most of this research has focused on how discount rates are influenced by differences in the magnitude or timing of those outcomes (e.g., Benzion, Rapoport, & Yagil, 1989; Keren & Roelofsma, 1995; Kirby & Herrnstein, 1995; Scholten & Read, 2006; Thaler, 1981). A second research stream has focused on how these choices correlate with other individual differences, such as smoking behavior (Baker, Johnson, & Bickel, 2003; Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008) or demographic characteristics (Frederick, 2005). A third focus is on the influence of ephemeral states, such as whether participants have been aroused by viewing women in bikinis (Van den Bergh, Dewitte, & Warlop, 2008) or by the sight or scent of freshly baked cookies (Li, 2008).

The present article falls into a fourth stream of research that examines whether, and how, discounting is affected by the description of options. For example, Magen, Dweck, and Gross (2008) found that respondents are markedly more patient if the choice between "receiving $100 now" and "receiving $140 in one year" is recast as "receiving $100 now and *receiving nothing in one year*" versus "*receiving nothing now* and $140 in one year." Read, Frederick, Orsel, and Rahman (2005) found that outcomes are discounted much less when the time to them is referenced by the date of their occurrence (e.g., "on June 3, 2012") than the intervening interval (e.g., in 15 weeks). Similarly, for choices involving longer horizons, Frederick, Read, LeBouef, and Bartels (2011) found less discounting when references to the future were made in terms of the age the respondent will be at that time (e.g., "when you are 45") than in terms of the number of the correspond-

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ing number of years. Such framing effects provide clues about how options are mentally represented, and about why that affects preferences.

In a typical study of intertemporal choice, choices are framed as being between a Smaller, Sooner (*SS*) option and a Larger, Later (*LL*) option.[1] In one widely used measure, for instance (Kirby, Petry, & Bickel, 1999), subjects choose between pairs such as "$80 now [*SS*] OR $85 in 157 days [*LL*]." We call this standard frame the *Amount* frame. Most psychological models of discounting are based primarily on data derived from this frame (e.g., Killeen, 2009; Loewenstein & Prelec, 1992; Scholten & Read, 2006, 2010).

The experiments conducted in this article vary the framing of outcomes. We compare variants of the *Amount* frame with two others, which we call the *Interest-rate* and *Interest-total* frames. We also develop the DRIFT model, which treats intertemporal choices as drawing on processes common to other multi-attribute choices. The attributes we focus on are those familiar from earlier accounts of time discounting, including absolute differences between outcomes, proportional differences, interest rates, and the broader context of consumption and investment. The studies show systematic effects that are predicted, or readily accommodated, by the DRIFT model. Before presenting any psychology, however, we first describe the economic theory of intertemporal choice, and we discuss some preference patterns that appear anomalous with respect to it.

Economic Theory and Its Anomalies

To provide a background for our empirical work, we begin with some formal language and a small amount of *normative* theory. As noted, nearly all experimental work involves what we call the standard *Amount* framed task, in which respondents choose between Smaller Sooner (*SS*) and Larger Later (*LL*) amounts of money, say, between $100 now or $110 in 1 year. We denote the sooner amount as x_S which is received at time t_S and the later amount as x_L received at time t_L. Thus, $SS = (x_S, t_S)$, and $LL = (x_L, t_L)$. The later amount x_L can be understood as the outcome from investing x_S at an *experimental interest rate*, i_E, over the interval separating the two outcomes. In our example:

$$x_L = x_s(1 + i_E)^{t_L - t_s} \text{ or } \$110 = \$100\ (1 + .1)^{1-0}.$$

The experimental interest rate, in this case 10%, is chosen by the experimenter. The decision maker evaluates the options drawing on their own personal interest rate, denoted i_ψ. Economic theory predicts that decision makers will prefer *LL* over *SS* only if the experimenter offers a return on investment greater than this interest rate (see Cubitt & Read, 2007). That is, preferences will follow the following inequality, with *LL* preferred if the right hand side is greater:

$$i_{\mathrm{E}} \gtreqless i_\psi$$

In our example, a decision maker with a personal interest rate of 20% would take *SS*, whereas one with a rate of 5% would take *LL*.

Thus far, the economic and psychological models coincide. In economic theory, however, the personal interest rate is not arbitrary, but determined by each individual's lending and borrowing opportunities in credit markets. Everybody has an opportunity cost for money built up from his or her current "financial portfolio," which can include credit card bills, savings accounts, mattresses, and investments. If Mary is currently saving money at 3% per year, for example, then 3% per year is her opportunity cost for delaying the receipt of money. If the experimenter offers Mary a 10% return, she should therefore choose *LL*, since 10% is higher than 3%. On the other hand, if John has no savings and an unpaid balance on his credit card costing 18%,[2] he should take *SS* when offered the same options, because, for him, money received now used to reduce his debt will "earn" 18%. Thus, in theory, each person's personal interest rate i_ψ will equal i_M, their opportunity cost for capital (see Price, 1993, for a comprehensive account, and Coller & Williams, 1999, for a discussion of this in the context of experimental economics.).

Indeed, as first shown by Fisher (1907, 1930), economic theory not only predicts that decision makers will act *as if* i_ψ is equal to i_M, but that the *psychological* rate of interest, meaning their "underlying" degree of impatience or time preference, will actually converge on their opportunity cost for money—this is why we used the subscript ψ to denote the personal interest rate. To see why, consider Mary. She will continue saving money until she reaches a point at which the value of an extra $1.00 of immediate consumption is worth at least as much as an extra $1.03 of consumption in 1 year. Consequently, if offered the opportunity to take an extra dollar now, or invest it for 1 year at 3%, she will be indifferent: Her underlying *psychological* interest rate, i_ψ, will have come to match the economic rate of 3%. The same argument applies to John, who will have borrowed as much as he wants at 18% and for whom i_ψ is also therefore 18%.[3]

If the above analysis fully described behavior, intertemporal choices between dated monetary rewards would not interest psychologists. Psychologists *are* interested, however, because the economic analysis falls short even as a rough approximation of intertemporal choice (for a review, see Frederick, Loewenstein, & O'Donoghue, 2002). Perhaps the core anomaly is that the psychological interest rates inferred from people's choices (we denote

[1] In matching studies, the situation is much the same except that respondents are asked to complete a missing smaller-sooner or larger-later amount to make two options equivalent.

[2] John *should* have no savings, since any savings will certainly be earning less than 20%. We know, however, that many people simultaneously roll over credit card debt and keep savings earning much less than that debt (Banks, Smith, & Wakefield, 2002; Gross & Souleles, 2002).

[3] This should not be interpreted as implying that there are no individual differences in time preference, but only that the economic model holds that respondents who face the same market rate will have aligned their psychological rates with that market rate before they arrive at the lab to make their marginal choices. Imagine an "ant" and a "grasshopper" that each earn $1,000 a month and can save at 3%. The ant is more patient than the grasshopper and saves $900 every month, whereas the grasshopper saves only $100. Now both come into the laboratory and are asked whether they want to receive $1 now, or invest it at 3%. Both will be indifferent, because the fact they are saving some of their income demonstrates they are already consuming all they want given their respective incomes and the 3% interest rate. Clearly, however, the ant is much more patient than the grasshopper. According to the economic model, however, this will not be reflected in the psychological interest rate, as it is measured by choices between delayed amounts of money. This prediction is known as the Fisher separation theorem (see Hirshleifer, 1958).

them $\hat{i}_\psi$) deviate from market rates and almost always exceed them. Overlaying this major anomaly are several others including two that will be our primary focus: The magnitude effect ($\hat{i}_\psi$ is lower for larger amounts), and the delay effect ($\hat{i}_\psi$ is lower for longer delays). These departures have motivated descriptive theories of intertemporal choice that depart radically from the normative theory first outlined by Fisher (for examples, see Ainslie, 1975; Killeen, 2009; Leland, 2002; Loewenstein & Prelec, 1992; Rubinstein, 2003; Scholten & Read, 2006, 2010).

The DRIFT Model

We propose that the size, existence, and even direction of major anomalies in intertemporal choice are strongly affected by option framing, which serves to emphasize some features and mask others. The features constitute arguments for and against each option, with the strength of the arguments determined by both the attractiveness of the feature value, and the attention paid to it. To illustrate in an everyday context, your decision of whether to buy a car with good gas mileage depends, in part, on how expensive gas is and how much you drive, but also on how much attention you pay to gas mileage at the moment of purchase (as well as how much you think about other things, such as the greater safety afforded by a heavier gas guzzling vehicle). Because different frames allocate attention differently, different preferences can result.

In our experiments, the focal independent variables are variations in the framing of x_L. Below, we specify some outcome features that can receive differential attention in response to these variations, along with how the different frames adopted in our experiments relate to these features. This list does not cover every possible relevant outcome feature, but it does include most of the natural perspectives from which intertemporal tradeoffs of monetary rewards can be viewed.

D(ifference): The absolute difference between the two outcomes. In this case, the additional earnings $x_L - x_S$. We propose that D receives greatest weight in the *Amount* frame (and that major findings from intertemporal choice studies partly result from its widespread adoption by researchers).

R(atio): The relative, or proportional, difference between the two outcomes: $(x_L - x_S)/x_S$. We propose that R receives greatest weight in the *Interest-total* frame.

I(nterest): The experimental interest rate: i_E. Feature I and R differ for intervals other than 1 year. We propose that I receives greatest weight in the *Interest-rate* frame.

F(inance): The degree to which the experimenter's offer is expressed as an opportunity to invest rather than consume. This feature is enhanced by the *Investment* frame, which can be applied to all of the other frames.

The DRIFT model summarizes the qualitative effect of these four features (DRIF) on choice, with T representing time. The model can be given the following compact summary:

$$W_D D + W_R R + W_I I + W_F F \gtreqless W_T T$$

According to the DRIFT model, decision makers balance a weighted average of the four DRIF features, against the importance given to the time (T) to wait for the larger reward. If the left hand side is greater (i.e., if the DRIF features outweigh T), then LL is chosen; if not, then SS is chosen. We conceptualize the weights $W_i \geq 0$ as representing the attention paid to feature i. Since attentional capacity is limited, attention allocated to one feature reduces the weight accorded to other features; thus, combining frames usually yields intermediate effects, as we shall later see. For the current article, there is no need to distinguish between the weight W_F and the attribute value F. We include both to acknowledge that, in principle, more or less attention can be paid to what the money will be used for (W_F), and the money can be considered for either immediate consumption, or investment, or some combination of the two (F). It is generally important to recognize that the impact of a given feature will be a function of the magnitude of that feature, and its importance in decision making.

In contrast with most conventional discounting models, which are alternative-based, DRIFT is attribute-based. In other words, rather than discounting outcomes according to their temporal distance, temporal differences are set against magnitude differences. From an attribute based perspective, many of the widely reported anomalies in intertemporal choice (including the delay and magnitude effect, upon which we focus) can be seen as following directly from familiar psychophysical principles (for other attribute-based approaches, see Killeen, 2009; Leland, 2002; Rubinstein, 2003; Scholten & Read, 2010).

DRIFT is not proposed as a formal quantitative model, which would go beyond our current goals and data. However, we can indicate some modeling requirements for future research. In addition to indices of attention, the weights W_i would serve as "scaling parameters." All else equal, the smaller the unit of the feature, the larger its weight, and the more features that are combined on the same side of the equation, the smaller the weight of each. Furthermore, there are likely to be nonlinearities in the impact of the model features. One basic nonlinearity is diminishing sensitivity, which is that the marginal impact of an amount decreases with its magnitude. We suspect that diminishing sensitivity will apply to features D, R, and I.[4] For instance, an increase in the interest rate from 1% to 2% will have greater impact than one from 20% to 21%. Similarly, there would be nonlinearity in the definition of T. While the DRIFT model with a linear T mimics some elements of hyperbolic discounting (patience increasing with increases in delay), a concave time-weighing function over delays (Scholten & Read, 2010; Zauberman et al., 2009) would be needed to produce time inconsistency, such that when both options are delayed by a common period of time preferences for SS can reverse in favor of LL. These modeling considerations are ignored in this article, which focuses on the qualitative implications of outcome framing.

The DRIFT model extends earlier attribute-based approaches to intertemporal choice by allowing for the consideration of multiple perspectives on choice. To illustrate, if attention is paid only to D,

[4] One modeling issue to be resolved is whether diminishing sensitivity operates on outcomes or on model features. For instance, in the original tradeoff model, diminishing sensitivity is applied to outcomes, that is, $v(x_L) - v(x_S)$, but, when applied to the D feature, we have $v(D)$, where v is a concave value function over increases.

so that W_R, and W_I equal 0, it is equivalent to a rudimentary version of Scholten and Read's (2010) tradeoff model, while if attention is paid only to R, so that W_D and W_I equal 0, it is a similarly rudimentary version of the interval discounting model (Scholten & Read, 2006). Finally, if attention is paid to both D and R, it mimics the original statements of the tradeoff model and the interval discounting model, in which both absolute and proportional differences matter.

The DRIFT model predicts that the magnitude effect and the delay effect arise from variations in the three DRI factors, and that the size of both effects will reflect the weights W_i applied to those factors. The *magnitude effect* occurs because multiplying two amounts by a common constant (>1) increases D, which shifts preference toward *LL*. For example, if \$100 and \$110 are doubled to \$200 and \$220, the difference between them will double from \$10 to \$20. If decision makers pay any attention to D (i.e., if $W_D > 0$), the DRIFT model predicts a magnitude effect. The size of that effect, meaning how great an impact a given increase in D has on preference, will depend on W_D. As we expand on shortly, frames that direct attention toward D will therefore show larger magnitude effects than frames that draw attention toward other features.

The *delay effect* arises when attention is focused on R as well as D. For a given interest rate, the strength of the arguments favoring *LL* will grow faster than those favoring *SS*, because while time (T) increases linearly, D increases exponentially. To illustrate this, suppose i_E is 10% and the decision maker is indifferent between \$100 now and \$110 in 1 year. If i_E is maintained and the discounting interval is extended to 3 years, the choice will be between \$100 now and \$133 in 3 years. While the interval will have tripled, the reward for waiting (D) will have more than tripled, as will the proportional difference (R). Consequently, preferences can shift toward *LL*.[5]

We propose that, relative to the Interest-rate and Interest-total frames, the standard Amount frame leads to more attention being allocated to D. This will lead to a strong magnitude effect and a delay effect. Alternative frames draw attention to other features, potentially changing preferences. The Interest-rate frame draws extra attention to I, and the Interest-total frame draws attention to R. To illustrate these effects, imagine an idealized frame which shifts all attention to I (i.e., $W_D = W_R = W_F = 0$), producing the following *reduced* version of the DRIFT model:

$$W_I I \quad \gtreqless \quad W_T T$$

Holding the interest rate constant, the left hand side would therefore remain unchanged when magnitudes are increased by a constant proportion, so that with this idealized frame, the following choices would be treated identically:

\$100 now OR \$121 in 2 years [I = 10% per year; R = 21%]

\$200 now OR \$242 in 2 years [I = 10% per year; R = 21%].

The magnitude effect would be eliminated. A similar argument would hold if all the decision weight was placed on feature R. Increasing outcomes by a common multiple will not change R, and, therefore there will be no magnitude effect if attention is exclusively focused on R. Thus, we predict the magnitude effect will be reduced when frames highlight the interest rate (I), the proportional difference (R), or both.

An additional consequence of putting all decision weight on feature I is that the *delay effect* will be reversed. To see why, consider what the reduced version of DRIFT predicts for the two choices below:

\$100 now OR \$110 in 1 year [I = 10% per year; R = 10%]

\$100 now OR \$133 in 3 years [I = 10% per year; R = 33%].

Since I is held constant while T increases, the reduced DRIFT model predicts a shift toward *SS* for longer time intervals—a reversal of the traditional delay effect. This does not hold, however, if all weight is placed on R (or D). The relative (and absolute) difference does increase with delay, and at a faster rate than delay. Focusing exclusively on R or D, therefore, will produce a delay effect.

The DRIFT model does not directly predict whether the level of discounting will be higher or lower for different frames. However, at least for decisions involving small amounts of money and short delays, Coller and Williams (1999) have found evidence that people are more patient when interest information is provided. In our studies, we investigate a wide range of magnitudes, and we predict that patience increases fastest under the standard Amount frame. Correspondingly, we predict the Interest-rate frame will induce greater patience for small values of x_S and for short delays. This difference will decrease and perhaps reverse as D increases, as occurs with increases in amount (x_S) and delay.

The DRIFT model also predicts that discounting will be reduced when outcomes are characterized as investment rather than immediate consumption opportunities, since this will increase the value of feature F. We expect that under the standard frame, when investment is not mentioned, people will be biased to treat earnings as immediate consumption opportunities (see Read & Powell, 2002, for evidence of this bias),[6] which corresponds to a low value of F.

In the following experiments, we compare discounting under Amount, Interest-rate, and Interest-total frames both with and without investment framing. We begin with a brief overview.

Overview

We present four experiments, each conducted using a different sample from the online panel of the Yale School of Management Internet laboratory (eLab), an electronic survey website which rewards participants with chances to win *Amazon.com* gift certificates. eLab has approximately 20,000 participants, and it receives about 4,000 unique visitors each month. Participants received a

[5] The most common version of the hyperbolic discount function, in fact, holds that the future value of x_L needed to equate x_S and x_L will increase linearly as a function of time. That is, indifference is maintained when $x_L = x_S(1 + kt_L)$ for some value of k (Mazur, 1987).

[6] An implication of the questions commonly asked in studies of intertemporal choice is that respondents are making tradeoffs between short-term increases in consumption and not in their income. For instance, many studies involve preferences over small time scales, such as \$10 today and \$15 in 2 weeks. This can only be considered a non-trivial choice if the decision maker is assumed to plan to consume an extra \$10 within the following 2 weeks than they otherwise would. Under any other circumstances, the choice of \$10 will be dominated by the \$15.

1/50 chance of a $50 Amazon.com gift certificate for their participation. To help ensure that no respondent participated in more than one study, all studies besides the first were advertised only to those who had not previously participated (others neither saw the advertisement nor had access to the link). Second, if there were two completed surveys originating from the same URL, the second entry was automatically excluded from the data.

Each study involved hypothetical choices between an *SS* option (available now) and an *LL* option. The hypothetical nature of the choices was not emphasized, although no respondent queried us on this, as respondents were familiar with eLab conventions and were informed explicitly how they were being compensated (the chance of a certificate). In all studies, *SS* was immediate and involved either a small ($700) or large ($70K) reward. Also in all studies, *LL* was either 1, 3, or 10 years in the future. Although the precise wording varied slightly between studies, and though Study 2 also involved an investment framing, the approximate content of the three basic frames was as follows:

> **Amount:** Receive $100 now or an extra $33 in 3 years.
>
> **Interest-rate:** Receive $100 now or an extra 10% interest per year over 3 years [compounded annually].
>
> **Interest-total:** Receive $100 now or an extra 33% after 3 years.

In all studies, we measured *patience* as the fraction of *LL* choices. Excepting Experiment 1, respondents responded to questions by clicking on buttons labeled either "Take the money now" or "Take the money later." Since Amount frames are so commonly used, they can be viewed as the standard against which to compare the results from other outcome frames. As noted in the foregoing discussion, we predicted that the Interest-rate and Interest-total frames would exhibit a smaller magnitude effect and a reduced or even reversed delay effect (because *I* remains unchanged while *T* increases), while the Amount and Interest-total frames would show the standard delay effect (because *D* and *R* increase faster than *T*). In addition, we predicted that patience would be increased when the decisions were characterized as investments (because this will increase *F*).

Finally, we anticipated that the Interest-rate frame would yield more patience than the Amount frame for smaller amounts of money and short intervals of time, but that this difference would attenuate or even reverse for larger amounts and longer intervals, as *D* is increasing in both magnitude and delay. Correspondingly, we expected there to be *some* amount/delay combinations for which the Amount frame would yield *greater* patience than the Interest-rate frame.

Experiment 1

In this study, we used investment language for describing choices and compared the standard Amount frame to the Interest-rate frame. We hypothesized the Interest-rate frame would yield a smaller magnitude effect (Hypothesis 1a [H1a]) and a reduced or even reversed delay effect (Hypothesis 1b [H1b]). Furthermore, based on earlier research, we predicted that at smaller magnitudes (when x_S = $700) the interest rate frame would show greater patience than the Amount frame (Hypothesis 1c [H1c]), but that this difference would be reduced for larger amounts (x_S = $70K).

Method

Three hundred and ninety-five eLab members started the survey, and 373 completed it. All analyses are conducted on the completers. Their mean age was 36 years (*Mdn* = 34, *SD* = 12.6); 64% were female, and 52% had a bachelor's degree or greater.

Each respondent answered 12 questions framed as investment opportunities. We varied *Magnitude* (x_S = $700 or $70K) and *Delay* to *LL* (1 or 3 years). At each magnitude/delay combination, we asked three questions corresponding to different experimental interest rates (4%, 8%, and 16%). The dependent variable was the proportion of *LL* choices (*patience*) at each delay/magnitude combination.

Each respondent was assigned to one of four frames: either the Interest-rate frame or one of three versions of the Amount frame, which we call the Amount-combined, the Amount-incremental, and the Amount-incremental plus "interest" conditions. An example of each frame is given below:

> **Interest-rate:** Would you rather receive $70,000 now or invest it for 1 year at an 8% interest rate?
>
> **Amount-combined:** Would you rather receive $70,000 now or invest it for 1 year to earn $75,600 in total?
>
> **Amount-incremental:** Would you rather receive $70,000 now or invest it for 1 year to earn $5,600?
>
> **Amount-incremental plus "interest":** Would you rather receive $70,000 now or invest it for 1 year to earn $5,600 in interest?

After seeing each question, respondents clicked a button indicating whether they would "Take the money now" or "Invest the money."

Prior to answering the questions, respondents received the following instructions:

> On each of the following pages, you will be faced with a choice between an immediate payment and an investment opportunity. When choosing, please consider the length of time the money will be invested and the annual interest rate.
>
> Keep the following in mind:
>
> [For those in Interest-rate frame only.] *The interest will be compounded annually.*
>
> The investments are binding. If you choose to invest, the money will not be available until after the investment period.

Results and Analyses

Summary. Table 1 presents the proportion of *LL* choices for each condition, and Figure 1 shows the relationships between Delay, Frame (collapsing over the three Amount conditions), and Magnitude. Figure 2 shows mean patience in both conditions at both magnitudes to highlight the magnitude effect. The main results were as follows:

Table 1
Mean Percentage of Patient Choices (Larger, Later [LL] Option) in All Conditions of Experiment 1

Condition	N	$700		$70K	
		1 year	3 years	1 year	3 years
Interest-rate	137	45 (36)	42 (36)	61 (37)	54 (37)
Amount-aggregate	77	23 (30)	24 (30)	52 (34)	60 (36)
Amount-incremental	76	22 (26)	28 (32)	55 (38)	63 (36)
Amount-incremental-interest	83	23 (36)	22 (31)	54 (36)	58 (38)

Note. Standard deviations are in parentheses.

1. The three Amount conditions show nearly identical results.

2. The magnitude effect was greater for the Amount frame than the Interest-rate frame (H1a).

3. In the Interest-rate frame, respondents became less patient with longer delays, reversing the delay effect often observed using amount frames (H1b).

4. The Interest-rate frame produced greater patience than the Amount frame for smaller amounts but not for larger ones (H1c).

Details. We first tested whether the three variants of the Amount frame differed by conducting a three-way analysis of variance (ANOVA) excluding the Interest-rate frame: A 3 (Condition: *Combined*, *Incremental*, *Incremental plus "interest"*) × 2 (Magnitude: *$700*, *$70K*) × 2 (Delay: *1*, *3 years*) ANOVA. No term containing Condition approached significance (*p*s range from .203 to .927), and the *Magnitude-difference*—the difference between the average patience in the $700 and $70K conditions—was also virtually identical across conditions (between 33% and 34%). For subsequent analyses, we pooled the three amount conditions, and in later studies, we restrict our attention to the Amount-incremental condition, which explicitly refers to *D*.

The next analysis was a 2 (Frame: *Amount*, *Interest-rate*) × 2 (Magnitude) × 2 (Delay) ANOVA. We obtained a highly significant main effect of Magnitude, $F(1, 371) = 191.4$, $p < .0001$, $\eta_p^2 = .34$, reflecting more choices of *LL* when x_S was $70K than when it was $700. This effect was moderated by Frame—Frame × Magnitude interaction, $F(1, 371) = 25.9$, $p < .0001$, $\eta_p^2 = .065$—confirming the magnitude effect was greater in the Amount frame (Magnitude-difference = 34%) than in the Interest-rate frame (16%), as highlighted in Figure 2 (H1a).

In support of H1b, a significant interaction was observed between Frame and Delay, $F(1, 371) = 16.2$, $p < .0001$, $\eta_p^2 = .042$, with patience decreasing with delay for the Amount frame ("hyperbolic discounting"), but increasing with delay for the Interest-rate frame ("anti-hyperbolic discounting"). Separate ANOVAs for the Amount and Interest-rate frames revealed that both effects were significant. In the Amount frame, patience was greater for the 1-year delay than for the 3-year delay, $F(1, 235) = 7.4$, $p = .007$,

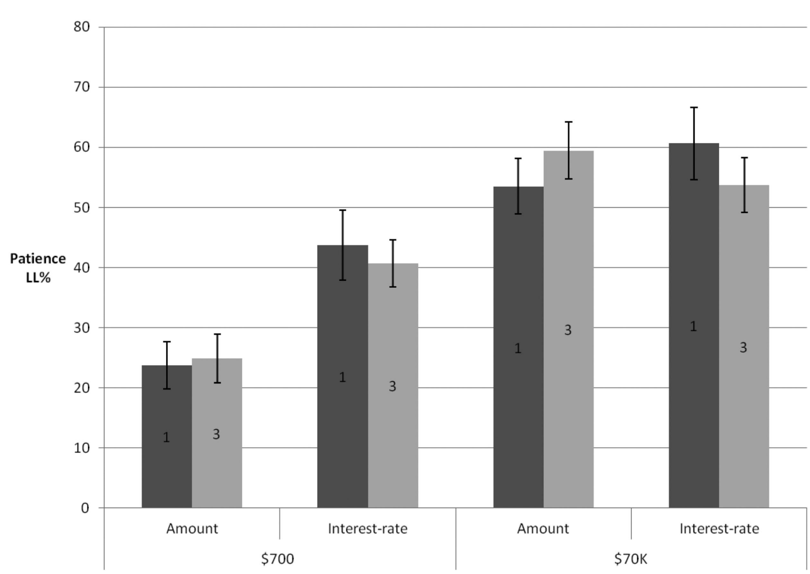

Figure 1. Patience (choice of Larger, Later [*LL*] option) in Amount and Interest-rate conditions of Experiment 1 when x_S = $700 and $70K. Numbers in bars indicate delays in years. Error bars indicate ±1.96 standard errors of the mean.

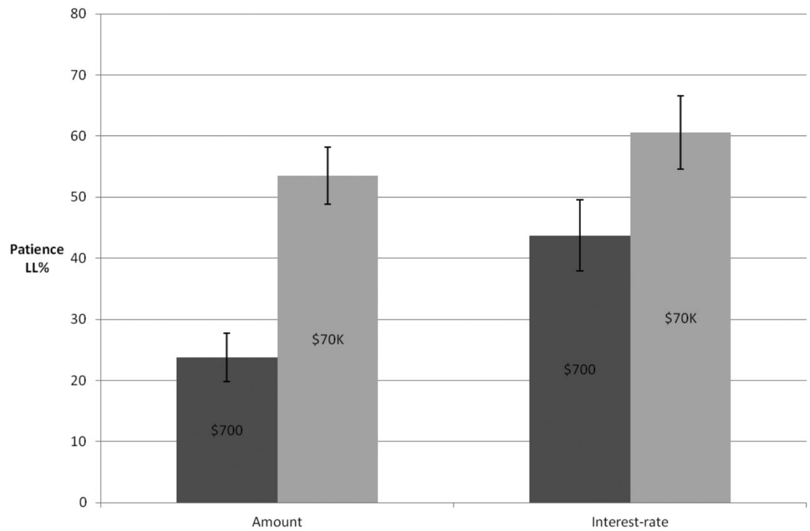

Figure 2. Magnitude effect in Amount and Interest-rate conditions of Experiment 1. Numbers in bars indicate magnitude of x_S. Error bars indicate ±1.96 standard errors of the mean. *LL* = Larger, Later option.

$\eta_p^2 = .030$; however, in the Interest-rate frame, it was greater for the 1-year delay, $F(1, 136) = 8.9$, $p = .003$, $\eta_p^2 = .061$.

In support of H1c, there was a significant effect of Frame, $F(1, 371) = 11.6$, $p < .001$, $\eta_p^2 = .030$, with average patience greater for the Interest-rate frame than the Amount frame. This effect was almost entirely attributable to the small magnitude condition, as suggested by the Frame × Magnitude interaction discussed earlier. We tested this by conducting a multivariate analysis of variance (MANOVA) comparing the Amount and Interest-rate frame at all four Delay/Magnitude combinations, and then conducting pairwise comparisons. The MANOVA was significant, $F(4, 381) = 14.04$, $p < .001$. The results of the pairwise comparisons are shown in Table 2 (which also shows equivalent comparisons for Experiments 2 and 3). When x_S = $700, the Interest-rate condition yielded significantly greater patience than the Amount condition at both delays, but when x_S = $70K, there was no difference between the two frames. Indeed, there was a non-significant *reversal* at the 3-year delay. This is consistent with our suggestion that the greater patience observed in the Interest-rate frame would reverse if the value of *D* was sufficiently great. Since *D* increases with time (as

Table 2
Comparison Between Patient Choices in Amount and Interest-Rate Frames in Experiments 1–3

Magnitude	Delay (years)	Patience-difference%	*SE*	*F* (*df*s)	η_P^2
		Experiment 1			
$700	1	19.8**	3.4	33.52 (1, 384)	.080
	3	14.9**	3.4	18.75 (1, 384)	.047
$70K	1	6.2	3.8	2.64 (1, 384)	.007
	3	−6.2	3.8	2.66 (1, 384)	.007
		Experiment 2			
$700	1	27.0**	4.1	42.874 (1, 252)	.145
	3	22.3**	4.0	31.181 (1, 252)	.110
	10	8.7*	4.2	4.313 (1, 252)	.017
$70K	1	−1.0	4.3	0.059 (1, 252)	.000
	3	−9.2*	4.5	4.216 (1, 252)	.016
	10	−14.7**	4.5	10.613 (1, 252)	.040
		Experiment 3			
$700	1	24.6**	6.6	14.07 (1, 141)	.091
	3	8.7*	6.1	2.01 (1, 141)	.014
	10	−1.5	6.2	0.06 (1, 141)	.000
$70K	1	−2.4	5.6	0.18 (1, 141)	.001
	3	−13.5**	6.0	5.15 (1, 141)	.035
	10	−20.0**	6.1	10.68 (1, 141)	.070

Note. Patience-difference% = average patience in Interest-rate frame minus that in Amount frame.
* $p < .05$. ** $p < .001$.

well as with i_E and x_S), we investigated this possibility further in Experiment 2 by examining delays of 10 years in addition to 1 and 3 years. In Experiment 3, we increased D further by increasing the experimental interest rates.

Experiment 2

We undertook to replicate Experiment 1 and examined further predictions of the DRIFT model. First, we tested our prediction that framing decisions as potential investments increases patience. Second, we added an Interest-total frame to those explored in Experiment 1. As discussed in the introduction, we anticipated that directing attention to the total interest (R) would reduce the magnitude effect relative to the amount frame.

In summary, we tested the following predictions:

> *Hypothesis 2a (H2a):* Choices would produce greater patience under an investment frame than a "neutral" frame.

> *Hypothesis 2b (H2b):* Relative to the Amount frame, both the Interest-rate and Interest-total frames would yield a smaller magnitude effect.

> *Hypothesis 2c (H2c):* Patience would increase with delay in the Interest-total and Amount frames but would decrease with delay in the Interest-rate frame.

Finally, based on both the results of Experiment 1 and the logic of the DRIFT model, we predicted the following:

> *Hypothesis 2d* (*H2d):* At sufficiently long delays and large magnitudes, the Amount-frame would induce greater patience than the Interest-rate frame.

Method

Respondents were 654 members of eLab, of whom 630 completed the survey; 60% of the completers were female, with a mean age of 35 years (Mdn = 30, SD = 11.6), and 61% had a college degree or higher. Most were employed either full-time (49%) or part-time (13%), while 19% were students, and 3% were retired.

Each respondent was randomly assigned to one of five framing conditions. One was the Interest-rate (described as investment) frame used in Experiment 1:

> **Interest-rate/Invest:** Would you rather receive $700 now or invest it at a 4% annual Interest-rate for 3 years?

The remaining four conditions comprised a 2 (*Investment frame*) × 2 (*Outcome frame*) between-subjects design:

> **Amount/No invest:** Would you rather receive $700 now or receive an additional $88 in 3 years?

> **Interest-total/No invest:** Would you rather receive $700 now or receive an additional 12% in 3 years?

> **Amount/Invest:** Would you rather receive $700 now or invest it to receive an additional $88 in 3 years?

> **Interest-total/Invest:** Would you rather receive $700 now or invest it to receive an additional 12% in 3 years?

Results

Summary. The results, shown in Table 3, support the DRIFT model. The most notable are summarized below:

1. Framing choices as investments increases patience (H2a).
2. The magnitude effect was much smaller for the two interest frames than the Amount frame (H2b).
3. For the Amount and Interest-total frames, delay increased patience; for the Interest-rate frame, delay decreased patience (H2c).
4. In the Amount frame, patience was increasing in D. As amounts increased, the framing effects reversed. At short delays, the Interest-rate frame elicited more patience than the Amount frame. However, for large amounts and long delays (i.e., when D was large), the Amount frame elicited more patience (H2d).

Analyses. We first focused on the four conditions that crossed the outcome and investment frames (the first four rows in Table 3, the first four "clusters" in Figures 3a, 3b, and 4). Restricting ourselves to these conditions, we conducted a 2 (Frame: *Amount*, *Interest-total*) × 2 (Investment: *No invest*, *Invest*) × 2 (Magnitude) × 3 (Delay: *1*, *3*, *10 years*) ANOVA.

Table 3
Mean Percentage of Patient Choices (Larger, Later [LL] Option) in All Conditions of Experiment 2

			$700			$70K		
Invest	Frame	*N*	1 year	3 years	10 years	1 year	3 years	10 years
No	Amount	124	16 (26)	13 (22)	24 (29)	47 (37)	45 (36)	55 (36)
	Interest-total	127	27 (33)	34 (37)	41 (38)	44 (37)	53 (36)	60 (37)
Yes	Amount	127	23 (29)	20 (28)	30 (29)	66 (34)	64 (35)	62 (34)
	Interest-total	125	35 (34)	42 (35)	46 (34)	56 (37)	63 (34)	67 (34)
	Interest-rate	127	50 (36)	43 (35)	39 (37)	65 (36)	55 (36)	48 (38)

Note. Standard deviations are in parentheses.

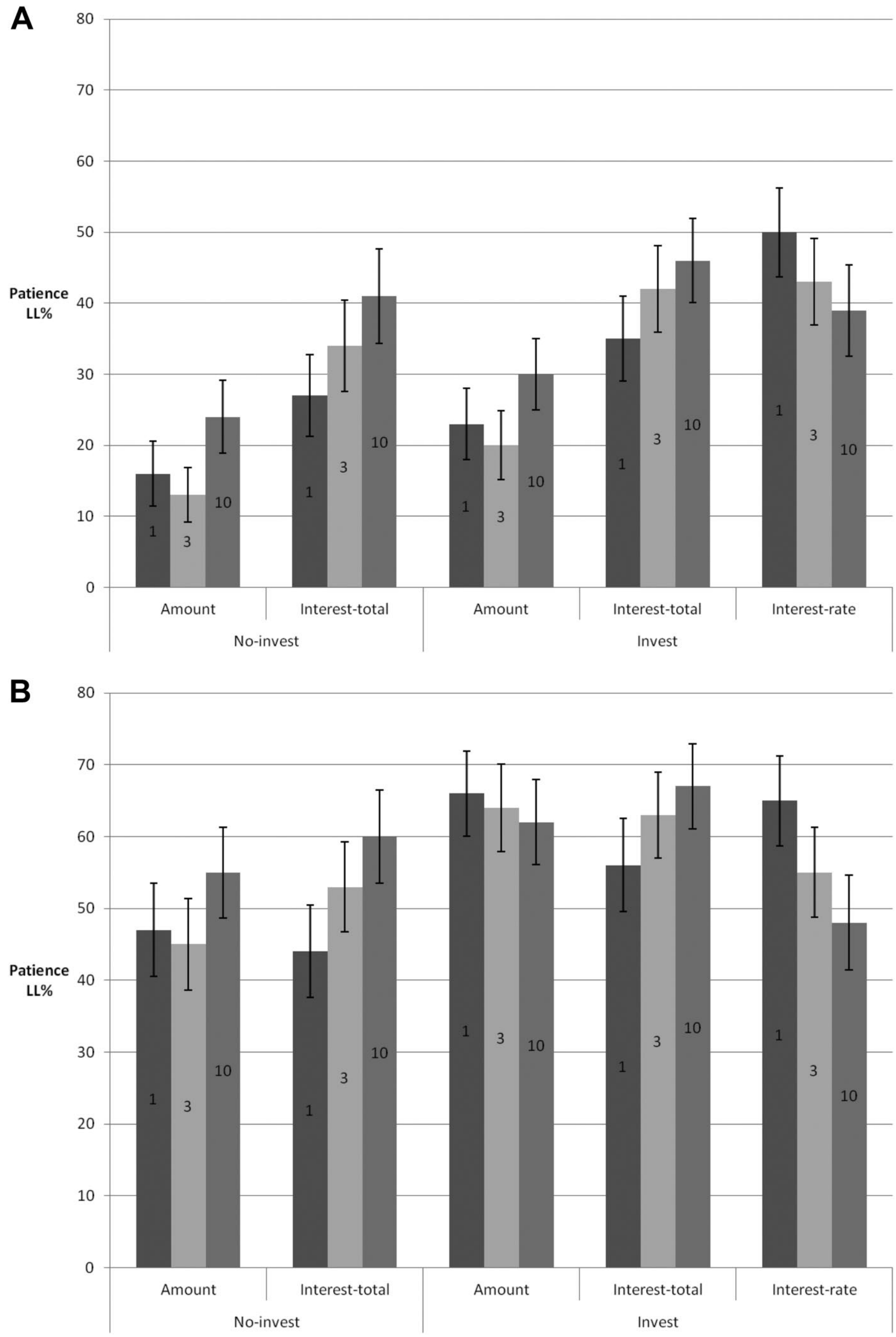

Figure 3. (A) Patience in all conditions of Experiment 2 when x_S = \$700. (B) Patience in all conditions of Experiment 2 when x_S = \$70K. Numbers in bars indicate delays. Error bars indicate ±1.96 standard errors of the mean. *LL* = Larger, Later option.

As predicted (H2a), there was a main effect of Investment frame, $F(1, 500) = 18.96$, $p < .0001$, $\eta_p^2 = .037$. The Investment frame increased patience, although the effect was moderated by Magnitude, $F(1, 500) = 5.65$, $p = .018$, $\eta_p^2 = .011$. This is highlighted by Figure 4 (first four clusters), which shows that the impact of the Investment frame is greater for larger rewards (when x_S = \$70K rather than \$700). Correspondingly, the magnitude effect was greater for the Investment than No-investment frame. Since investments typically involve large amounts of money, it is somewhat surprising that an explicit investment frame is more influential for large amounts (when we might expect the large amount to automatically trigger investment thinking) than small ones.

Overall, we obtained a highly significant Magnitude effect, $F(1, 500) = 522.55$, $p < .0001$, $\eta_p^2 = .511$, though as Figure 2 clearly

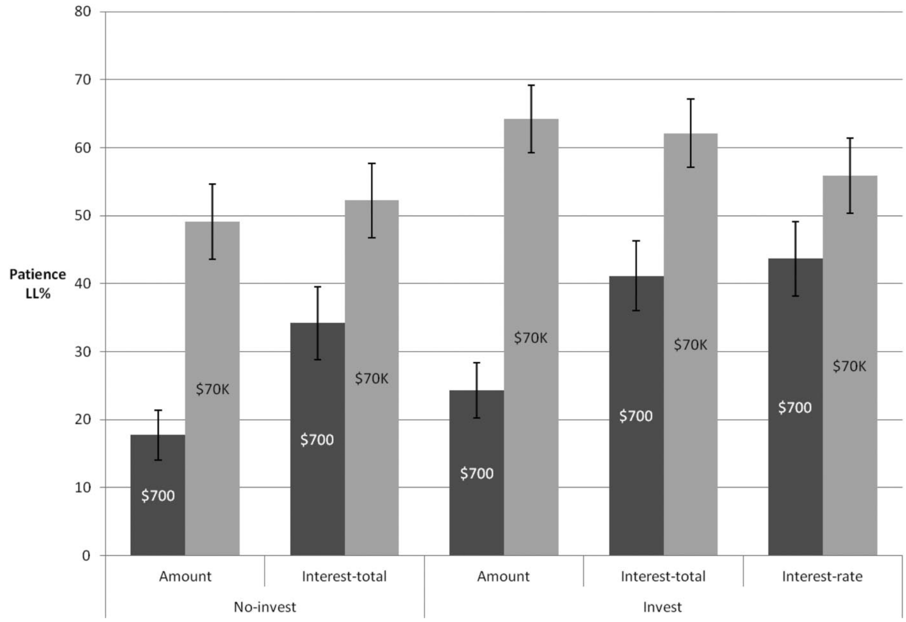

Figure 4. Magnitude effect in all conditions of Experiment 2. Numbers in bars indicate magnitude of x_S. Error bars indicate ±1.96 standard errors of the mean. *LL* = Larger, Later option.

reveals, it was significantly greater for the Amount than for the Interest-total frame: Frame × Magnitude interaction, $F(1, 500) = 44.71$, $p < .0001$, $\eta_p^2 = .082$. Finally, we observed the predicted main effect (see H2c) that *Delay* increased patience, $F(2, 499) = 24.25$, $p < .0001$, $\eta_p^2 = .089$. This was further supported by separate tests, in both the Amount and Interest-total frame, for a linear trend of patience changing with delay. The linear trend was highly significant for both frames: Amount, $F(1, 249) = 12.1$, $p = .001$, $\eta_p^2 = .046$; Interest-total, $F(1, 250) = 37.86$, $p < .001$, $\eta_p^2 = .131$.

We next focused on the three individual Investment frames (i.e., rows and clusters 3–5), to compare the Interest-rate (an investment frame) with the Amount and Interest-total frames on a "level playing field." We conducted a 3 (Frame: *Amount*, *Interest-total*, *Interest-rate*) × 2 (Magnitude: *$700*, *$70K*) × 3 (Delay: *1 year*, *3 years*, *10 years*) ANOVA. This revealed a strong main effect of Magnitude, $F(1, 376) = 294.7$, $p < .0001$, $\eta_p^2 = .439$, and highly significant interactions between Frame and Magnitude, $F(2, 376) = 33.19$, $p < .0001$, $\eta_p^2 = .15$, and between Frame and Delay, $F(4, 1008) = 17.80$, $p < .0001$, $\eta_p^2 = .066$. The main effect of Frame was not significant, $F(2, 376) = 2.86$, $p = .058$, $\eta_p^2 = .015$.

The Frame × Delay interaction revealed that patience increased with Delay for the Amount and Interest-total frames, but was *decreasing* for the Interest-rate frame. A subsequent analysis focusing only on the Interest-rate frames confirmed a strong linear trend, $F(1, 126) = 24.01$, $p < .0001$, $\eta_p^2 = .161$. All three frames therefore showed highly significant linear trends, but the direction was upward (increasing patience) for the Amount and Interest-total frames and was downward (decreasing patience) for the Interest-rate frame. As predicted by the DRIFT model (H2c), the frequently reported hyperbolic discounting effect occurs for the Amount frame (when x_S = \$700) and Interest-total frame (because features D and R increase with delay) but not for the Interest-rate frame.

The Frame × Magnitude interaction confirmed H2b, with a much greater Magnitude-difference for the Amount frame (35%) than for the Interest-total (21%) or Interest-rate (12%) frames (see Figure 4). Student Newman–Keuls post hoc tests on the Magnitude-differences revealed (with $p < .05$) that the magnitude effect was significantly greater in the Amount frame than the Interest-total frame, and was significantly greater in the Interest-total frame than the Interest-rate frame.

To test our conjecture that as D increased, average patience would start off lower in the Amount frame but end up higher, we conducted a MANOVA comparing the Amount and Interest-rate frames at all Delay/Magnitude combinations. The MANOVA was highly significant, $F(6, 247) = 15.74$, $p < .001$, indicating that the two frames likely differed. Subsequent pairwise comparisons showed the predicted effect. When x_S = \$700, the Interest-rate condition yields significantly greater patience than the Amount condition at all delays. When x_S = \$70K, however, the situation is partially reversed. For the 1-year delay, the frames did not differ significantly, but for the 3- and 10-year delays, the Amount frame gave rise to more patience than the Interest-rate frame.

Overview of Experiments 3 and 4

In many real-world contexts, decision makers are exposed to multiple frames—either concurrently or sequentially. Loans, for instance, are often described in terms of both the required payments (corresponding to D) and the corresponding interest rate (I); at the time of writing, the largest provider of payday loans in the United Kingdom was offering the opportunity to "Borrow £265 plus interest & fees £45.52 [D]" at a "Representative APR 4214% [I]" (www.wonga.com). In the United Kingdom, the provision of the interest rate (APR, or annual percentage rate) is required by law.

In Experiments 3 and 4, we investigated the effect of combining frames. We expected the impact of the four DRIF features to be a "blending" of their separate effects, with the weights determined by how a limited pool of attentional capacity is distributed over outcome features. When frames are combined, therefore, the resultant weights will themselves be a combination of those arising from the constituent frames. For instance, if one frame directs most attention to *D*, while another directs most attention to *I*, then by combining them the attention directed to *D* and *I* will be intermediate between that directed to them in the separate frames.[7]

An alternative to frame-blending is frame-*adding*, in which the combination of frames increases the total amount of attention directed to the *DRIF* features (i.e., the *sum* of the attentional weights would increase). To illustrate the distinction between blending and adding, consider two possible response patterns when a payday loan is described in one or two ways. In blending, the preference for a loan described in terms of both *I* and *D* would be intermediate between that for a loan described as *I* or *D* separately. In adding, the loan would become successively less attractive as other payment terms are added, so that patience given an *I* and *D* description would be lower than that for either separate description.

In Experiment 3, we compared a composite of the Amount and Interest-rate frames to its constituents, and in Experiment 4, we compared a composite of the Interest-rate and Interest-total frames to its constituents. The choice tasks were similar to those used in the prior studies, though we increased the experimental interest rates to 6%, 12%, and 24%.

Experiment 3

Method

Respondents were 222 members of eLab, of whom 219 completed the survey. Among these, 55% were female, 63% held at least a college degree, and the mean age was 37 years ($Mdn = 31$, $SD = 12.75$). Most were employed either full-time (50%) or part-time (12%), while 12% were students, and 5% were retired.

Respondents made 18 choices between *SS* and *LL*, which varied by interest rate (6%, 12%, or 24%) delay (1, 3, or 10 years), and magnitude (x_S = \$700 or \$70K). Question order was randomized. Each respondent made choices framed in one of the following three ways:

> **Amount:** Would you prefer to receive \$700 now or invest it for 1 year for an additional \$42?
>
> **Interest-rate:** Would you prefer to receive \$700 now or invest it for 1 year at 6% interest per year?
>
> **Composite:** Would you prefer to receive \$700 now or invest it for 1 year for an additional \$42 (6% interest per year)?

With respect to the two constituent frames, we made the same predictions as in our first two experiments: (1) the Interest-rate frame would yield a smaller magnitude effect than the Amount frame, (2) patience would be increasing with delay for Amount frame, and (3) patience would be decreasing with delay for the Interest-rate frame. Most importantly for this study, we predicted the composite frame would yield intermediate magnitude and delay effects (Hypothesis 3a [H3a] and Hypothesis 3b [H3b], respectively). We also revisited the hypothesis that as *D* becomes sufficiently large—which occurs with increases in x_S or delay—the Amount frame will eventually yield greater patience than the Interest-rate frame.

Results

Summary. Table 4 and Figure 5 present proportions of *LL* choices for each condition. The most notable results are summarized below:

1. The constituent frames replicated the results of Experiments 1 and 2. The Amount frame produced a greater magnitude effect than the Interest-rate frame. In the Interest-rate frame, patience was decreasing in delay at both magnitudes. In the Amount frame, patience was increasing for small magnitudes and was constant for large magnitudes.

2. The composite frame produced magnitude and delay effects intermediate between those of the constituent frames (H3a).

3. The Amount frame showed increasing patience, the Interest-rate frame showed decreasing patience, and the Composite frame showed constant patience (H3b). In the Composite frame, people display what is often referred to as "exponential" discounting, with the same level of patience at all delays.

4. For choices involving the high value of x_S the Amount frame induced more patience than the Interest-rate frame, an effect that increased in delay.

Analyses. We conducted a 3 (Frame: *Amount*, *Composite*, *Interest*) × 3 (Delay: *1*, *3*, *10 years*) × 2 (Magnitude: *\$700*, *\$70K*) ANOVA. There were main effects of Magnitude and Delay. As usual, the Magnitude effect, $F(1, 216) = 135.0$, $p < .0001$, $\eta_p^2 = .385$, was very large. The Delay effect, $F(2, 432) = 5.22$, $p = .006$, $\eta_p^2 = .024$, was that, on average, patience *decreased* with delay, with the proportion choosing *LL* falling from 57% for a 1-year delay to 52% for a 10-year delay; the linear trend for Delay was significant, $F(1, 216) = 7.86$, $p = .006$, $\eta_p^2 = .035$.

There was no significant main effect of Frame ($p = .925$), but Frame did interact strongly with Magnitude and Delay, in the

[7] This also allows for lexicographic response to frames, with some "trumping" others when they are viewed concurrently, if the decision maker has some reason to judge some frames as more normatively correct than others. Such trumping was observed in follow-ups to Kahneman and Tversky's (1984) "Asian disease" problem, which suggest that the "lives lost" version dominates the "lives saved" one (e.g., Kühberger, 1995; Reyna & Brainerd, 1991). Similarly, in their examination of the date/delay effect, Read et al. (2005) showed that simultaneous presentation of both date and delay frames led to preferences identical to those exposed only to the delay frame.

Table 4
Mean Percentage of Patient Choices (Larger, Later [LL] Option) in All Conditions of Experiments 3 and 4

			$700			$70K		
Experiment	Frame	*N*	1 year	3 years	10 years	1 year	3 years	10 years
3	Amount	74	31 (39)	39 (37)	43 (35)	73 (35)	74 (35)	72 (35)
	Composite	72	44 (42)	41 (36)	42 (34)	68 (35)	67 (35)	61 (35)
	Interest-rate	73	56 (39)	49 (36)	41 (39)	70 (35)	60 (35)	52 (35)
4	Interest-total	75	54 (38)	59 (39)	63 (38)	70 (35)	76 (34)	72 (37)
	Composite	131	55 (39)	58 (38)	55 (37)	64 (38)	66 (35)	64 (37)
	Interest-rate	61	59 (38)	54 (38)	52 (40)	68 (33)	62 (35)	55 (41)

Note. Standard deviations are in parentheses.

manner predicted by Hypotheses 3a and 3b. First, the Frame × Magnitude interaction, $F(2, 216) = 9.95$, $p < .0001$, $\eta_p^2 = .084$, was expected to reflect the following ordering for the magnitude effect: Amount > Composite > Interest-rate. As can be seen in Figure 6, this prediction held numerically; the difference in patience between the large and small rewards was 35% for Amount, 23% for Composite, and 13% for Interest-rate. Student Newman–Keuls post hoc tests on the Magnitude-differences confirmed each pairwise comparison was significant at $\alpha = .05$, supporting H3a.

The Frame × Delay interaction, $F(4, 432) = 6.45$, $p < .0001$, $\eta_p^2 = .056$, indicated that delay differed between frames. We had predicted increasing patience for the Amount frame, decreasing patience for the Interest-rate frame, and something intermediate for the Composite frame (H3b). Inspection of Figure 5 shows decreasing patience for the Interest-rate frame at both magnitudes, and increasing patience for the Amount frame when $x_S = \$700$, but not when it is $70K. Separate within-subject contrasts conducted for each Frame/Magnitude combination, testing for a linear trend for Delay, revealed linear trends for the $700/Amount condition, $F(1, 70) = 9.60$, $p = .003$, $\eta_p^2 = .121$, and the opposite linear trend for the $700/Interest-rate condition, $F(1, 70) = 9.60$, $p = .003$, $\eta_p^2 = .147$. No trend was significant for the $70K/Amount condition ($F < 1$ for both linear *and* quadratic trends), but the linear trend *was* highly significant for the $70K/Interest-rate condition, $F(1, 71) = 20.87$, $p < .001$, $\eta_p^2 = .227$, indicating decreasing patience with delay.

Most importantly, the pattern for the Composite frame lies between its constituent frames. We tested this by conducting three separate ANOVAs, one for each possible pairwise comparison, testing the individual linear Delay by Frame contrasts, which indicate whether the difference in patience between pairs of frames changes linearly with delay. In each case, the linear contrast was significant: Amount compared to Composite, $F(1, 144) = 5.05$, $p = .026$, $\eta_p^2 = .039$; Composite compared to Interest-rate, F(1,

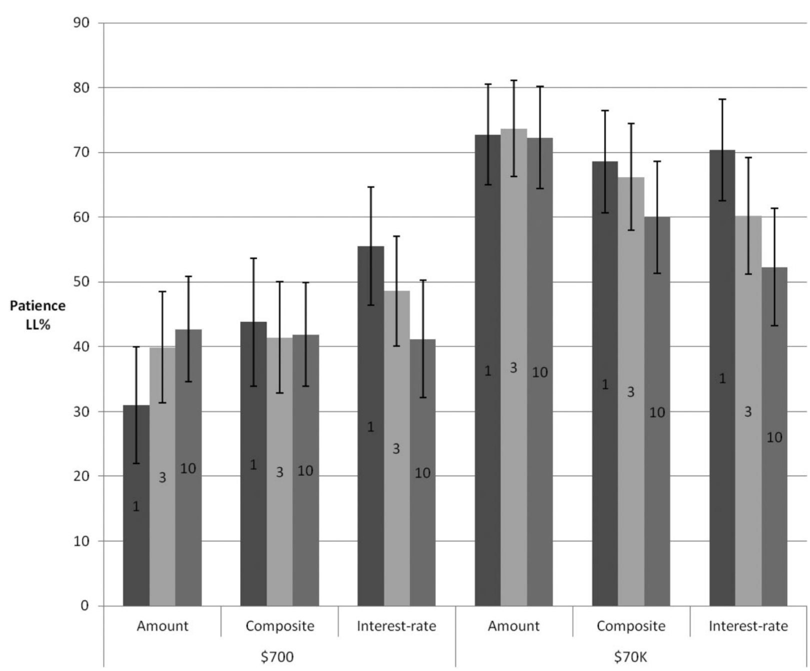

Figure 5. Mean patience in all conditions of Experiment 3. Numbers in bars indicate delays. Error bars indicate ±1.96 standard errors of the mean. *LL* = Larger, Later option.

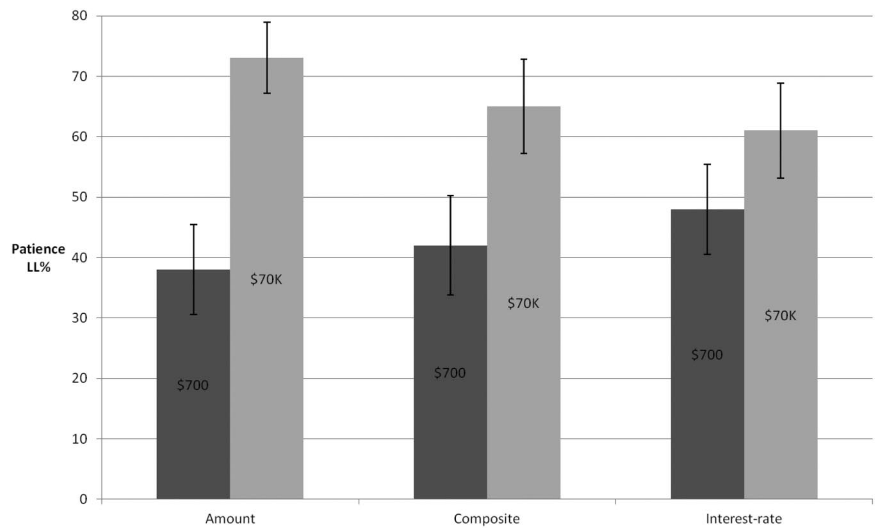

Figure 6. Magnitude effect in all conditions of Experiment 3. Numbers in bars indicate magnitude of x_S. Error bars indicate ± 1.96 standard errors of the mean. *LL* = Larger, Later option.

143) = 6.93, p = .009, η_p^2 = .038; Amount compared to Interest-rate, F(1, 145) = 25.28, p < .0001, η_p^2 = .146. This provided support for H3b.

As with Experiments 1 and 2, the impact of D differs qualitatively between the Amount and Interest-rate frames. Patience is increasing in D for the Amount frame, but decreasing in D for the Interest-rate frame (when D is implicit). As in earlier studies, we conducted a MANOVA, which showed that patience differs significantly between the Amount and Interest-rate frames, F(6, 136) = 7.89, p < .001. This effect is broken down by means of the pairwise comparisons reported in Table 2. As in the earlier studies, the Interest-rate frame induced more patience for small amounts/small delays, but this framing effect is gradually eliminated and (in this study, considerably) reversed for large amounts/large delays. Across all studies, patience increases in D much more rapidly in the Amount than the Interest-rate frame.

Experiment 4

We next compared the Interest-total and Interest-rate frames to their composite frame. We expected to replicate one finding from Experiment 2—that patience would be increasing in delay with the Interest-total frame, but decreasing in delay with the Interest-rate frame (Hypothesis 4a [H4a]). Again, we predicted the composite frame would yield intermediate effects (Hypothesis 4b [H4b]).

Method

Respondents were 278 members of eLab, 265 of whom completed the survey. The demographics were essentially identical to those of previous studies: 55% were female, 57% with a college degree or higher, and the mean age was 34 years (Mdn = 30, SD = 12.0). Most were employed either full-time (50%) or part-time (10%), while 14% were students, and 5% were retired.

We used much the same design as Experiment 3, though the question wording was changed slightly to accommodate the new frames.

Interest-rate: Would you prefer to receive $700 now or invest it for 3 years at 6% interest per year?

Interest-total: Would you prefer to receive $700 now or invest it for 3 years to receive an additional 19%?

Composite: Would you prefer to receive $700 now or invest it for 3 years to receive an additional 19% (6% interest per year)?

Results

Summary. Table 4 presents proportion of *LL* choices for each condition. The major results are as follows:

1. Patience was increasing in delay for Interest-total frame, but decreasing in delay for the Interest-rate frame (H4a).

2. The composite frame yielded intermediate results (H4b). In particular, patience was unaffected by delay (as in exponential discounting).

3. Though significant, the magnitude effect was much smaller than that found in the Amount frames from earlier studies.

Details. We conducted a 3 (Frame: *Total*, *Composite*, *Rate*) × 3 (Delay: *1 year*, *3 years*, *10 years*) × 2 (Magnitude: *$700*, *$70K*) ANOVA. The Magnitude effect was significant, F(1, 268) = 29.01, p < .0001, η_p^2 = .10, but much smaller than in Experiments 1–3, which included Amount frames (where η_p^2 ranged from .36 to .40). The comparatively small magnitude effect in this study did not differ significantly across frames.

The only remaining significant effect is a Delay × Frame interaction, F(4, 528) = 5.72, p < .001, η_p^2 = .04. As seen in Figure 7, all conditions have the same level of patience for the 1-year delay. Further delays decrease patience in the Interest-rate frame, but decrease patience in the Interest-total frame. The Com-

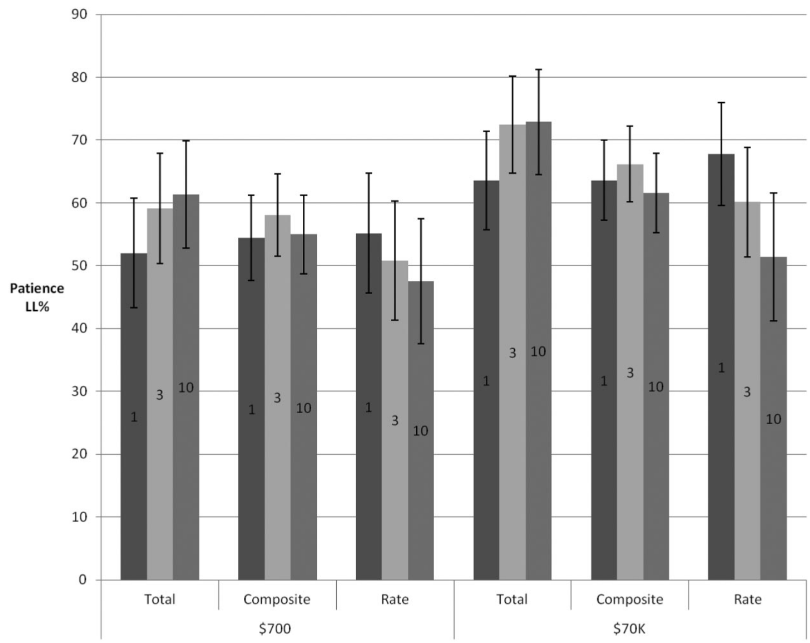

Figure 7. Mean patience in all conditions of Experiment 4. Numbers in bars indicate delays. Error bars indicate ±1.96 standard errors of the mean. *LL* = Larger, Later option.

posite frame yields intermediate effects, as predicted by H3b, with patience levels unaffected by duration of delay to *LL*. We conducted a separate ANOVA for each of the three possible pairwise comparisons, to ascertain whether the difference in patience between conditions changes linearly with delay. In each case, the linear contrast was significant: Interest-total compared to Composite, $F(1, 204) = 4.30$, $p = .039$, $\eta_p^2 = .021$; Composite compared to Interest-rate, $F(1, 190) = 5.45$, $p = .021$, $\eta_p^2 = .021$; Interest-total compared to Interest-rate, $F(1, 134) = 12.29$, $p = .001$, $\eta_p^2 = .055$.

Discussion

We showed that outcome framing affects the size and even existence of two major intertemporal choice "anomalies"—the magnitude and delay effects. Moreover, framing effects interacted with the amounts being considered: When the amount of money being discounted was "small" (x_S = $700), frames that included information about interest (whether in terms of rates or total interest earned) significantly increased patience relative to the standard Amount frame; however, for "large" amounts (x_S = $70K), the reverse was true. Finally, describing choices as investments increased patience across all amounts and delays. In general, the patterns of preference documented in the standard frame (Amount/No-investment) differed both quantitatively and qualitatively from those observed using alternate frames.

Our DRIFT model provides a useful framework for making sense of these results. Consider a decision maker choosing between three future payments arising from investing x_S for time T, who is told one of the following three things:

D: You will earn **$100**;

R: You will increase your money by **50%** in total;

I: Your money will grow by **10%** per year.

Obviously, we would expect choices to be influenced by the precise values at which these variables are instantiated, even if the three descriptions were constrained to be normatively equivalent to each other. Thus, in its simplest form, the DRIFT model is simply the claim that when respondents consider a feature, their preferences will be nudged toward those they would express if they considered *only* that feature. In our experiments, attention was strongly manipulated by explicitly specifying one of these features (along with the x_S and T, and, sometimes, F).

Like other constructed preference models (Johnson, Häubl, & Keinan, 2007; Kahneman & Miller, 1986; Shafir, Simonson, & Tversky, 1993; Stewart, Chater, & Brown, 2006; Weber et al., 2007), our DRIFT model shares the core idea that the cognitive and affective systems have potential access to a range of preference building blocks, which are differentially evoked by different contexts. One question our studies raise, but do not answer, is whether there is a "correct" or canonical way to measure time preference. We would not assert that any one of our frames elicits the "true" value of the discount rate, or the form of the discount function, but would propose that conclusions drawn from studies using a single method should be interpreted cautiously. When respondents were exposed to a composite frame, the results fell between the two constituent frames. Respondents appeared to view each frame as providing a useful perspective on choice.

Our study is not the only one showing that different intertemporal choice frames produce qualitatively different results. For example, though hyperbolic discounting is widely reported as a "stylized fact" about human behavior, its apparent ubiquity stems largely from the homogeneity in research designs—typically studies involving choices between *SS* and *LL* options, where *SS* is available immediately and the delay to *LL* is varied, with outcomes described in terms of Amounts, and delays described in terms of units of time. When these procedures are modified, the evidence for hyperbolic discounting becomes much shakier. Indeed, we find here that the effect is reversed when outcomes are expressed as interest rates rather than amounts. Likewise, in earlier work (Read et al., 2005), we found hyperbolic discounting when time was described as a delay, but not when it was described in terms of calendar dates. Relatedly, Stewart, Reimers, and Harris (2012) showed that the shape of the discount function is highly dependent on the set of questions people are asked, with the height and curvature of the function increasing the more positively-skewed is the distribution of delays.

Framing effects give us information about the normative status of intertemporal choice behavior that cannot easily be obtained from observing discounting patterns using a single method. Choice patterns that deviate from the economic model outlined in the introduction have understandably attracted attention. Yet, the anomalous patterns are often not as clearly "anomalous" as claimed. This can be illustrated with the magnitude effect. With idealized frictionless capital markets it is indeed anomalous to discount amounts at different rates depending on their magnitude. But if there are greater proportional costs or risks associated with managing small amounts of money, the "correct" discount rate for money *will* be sensitive to magnitudes. And, indeed, the costs of present-to-future and future-to-present transactions do not scale up with transaction magnitude. For instance, the hassle of cashing a check imposes a fixed cost, which differs relatively little on whether that check is for $100 or $100,000. Management costs are a major reason why small loans (including what is called microcredit) cost more in interest than do larger loans (e.g., Shankar, 2006; Shreiner, 2000). The magnitude effect may therefore not be as "anomalous" as advertised. Similar arguments can be made for other intertemporal choice anomalies, which often look less anomalous upon a more complete specification of the economic problem that decisions maker face.[8]

Notwithstanding the foregoing appeal to tone down claims of irrationality, framing effects *do* undermine the normative status of discounting models, because economic analysis is intended to apply to *consequences*, not descriptions. This general principle of *descriptive invariance* has been widely discussed as a fundamental, if often tacit, requirement for rationality (e.g., Arrow, 1982; Kahneman & Tversky, 1984; Wakker, 2010). Descriptive invariance is assumed not just in rational choice models, but also in many psychological models of intertemporal choice, including Ainslie's (1975) account of hyperbolic discounting, Loewenstein and Prelec's (1992) generalized hyperbolic discounting model, Scholten and Read's (2006) interval discounting model, Killeen's (2009) additive-utility model, and many others. All these models assume that preferences between options can be determined by a specification of what is to be received and when. In this article, we have described several failures of descriptive invariance, and we propose DRIFT as a general approach to understanding such effects.

[8] To our knowledge, the sign effect has not been explicitly rationalized in the context of intertemporal choice, but Read, Frederick, and Airoldi (2012) have reviewed arguments for the rationality of hyperbolic discounting, and Loewenstein and Prelec (1992) have explained the delay/speedup asymmetry as a consequence of loss aversion. That is a framing effect, but unlike those described in this article it is a "rationalization" because the pain from failing to receive an expected outcome may well be objectively greater than the pleasure from receiving an unexpected outcome of equivalent size.

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